8-25-2018

Determination of the ordering for dry bulk shipping vessels

Tianyi Bao

World Maritime University

ITL-2017

Topic: Determination of the ordering for dry bulk shipping vessels

Name: Bao Tian Yi

Student Number: W1701427

Supervisor: Professor Zheng Shiyuan

Date of Submission: 30th June 2018

Abstract

Title of the dissertation: Determination of the ordering for dry bulk vessels.

This dissertation studies how determinants such as the freight rate index(and their variance sequences), the 1 year chartering rate, new-building prices, second-handed prices as well as LIBOR will influence the ordering for dry bulk shipping vessels including Capesize vessels, Panamax vessels and Handysize vessels, by using VECM model. But before the VECM model is applied, we need to first of all go through the unit root test to see if these time series we have chosen are stationary for us to use for the model; Then we will apply the GARCH model, followed by the co-integration test and the Granger-Causality test to find the possible stable relationship among the ordering quantity for dry bulk vessels and the determinants. Along with the results of the VECM model, the impulse response analysis will also be used to find the effect of the change of endogenous variables. In the end, we've found that determinants of the 1 year chartering rate, new-building prices and second-handed prices which are the endogenous variables have a long-term stabilized relationship with the ordering quantity, and those conclusions are very useful and vital for managers of shipping companies when making decisions about investing on shipping vessels.

Key words: Determination of the ordering, Investment on dry bulk vessels, 1 year chartering rate, new-building prices, second-handed prices, VECM model

Contents

1. Introduction

1.1 Backgrounds

As we know that dry bulk shipping market is one of the most important segment in the world's international marine transportation, the trading volume is next only to the tanker transportation. And in this shipping field, the top three commodities transported mostly are iron ore, coal and grain. According to the research, at the end of Aug, 2015, it is said that the total deadweight tonnage of the global dry bulk shipping fleet is about 750 million dwt, "equivalent to 43.39% of the word's fleet in deadweight."(Stable vessel-cargo matching in dry bulk shipping market with price game mechanism, Zixuan Peng, Wenxuan Shan, Feng Guan and Bin Yu, 2016)

Since the dry bulk shipping segment belongs to the globalized economy of the whole global market, the demand and supply from any economic sector in this united and integrated international market will have certain influence on the capacity in the dry bulk shipping market. Meanwhile, the existing capacity of the dry bulk shipping sector will limit the trading volume and the development space of transporting fleets in the future. The capacity of the dry bulk shipping sector, in my opinion, decided by two aspects: firstly, the total amount or the total volume of the dry bulk shipping fleets in the world; then secondly, the total deadweight tonnage, which represents transport capacity and also some of the transport efficiency of the whole fleets. This paper will study on the first side of the capacity of dry bulk shipping market, especially on the ordering volume of dry bulk shipping vessels.

It is clear that since the financial crisis occurred in the year of 2008, the whole shipping market has been in the prolonged recession and depression. As we know that new dry bulk shipping vessels usually need at least one or two years to construct, and since the investors could track the sign from the orderbook in the long run, the expectations for the future prospect of shipping market is very vital to the decisions

that managers made about the ordering volume of dry bulk ships, both on the shipping types and the total ordering amount. And a good investor should know how to make a reasonable and prospective forecasting and expectations in terms of various factors directly and indirectly, endogenetic and exogenous ones related to the object.
(https://finance.yahoo.com/news/dry-bulk-orderbook-falls-signals-210613220.html)

Although the global shipping industry is still in the depression phase, the dry bulk shipping segment has continued to recover itself and now has reached to a much healthier level. And reasons are probably that first of all, the situation of the over-supplied new-building shipping vessels has been improved. Then the second one is that the demand of bulk commodities needed to be transported is keeping increasing.
(http://wap.eworldship.com/index.php/eworldship/news/article?id=135144)

1.2 Research purpose

In this paper, several problems will be studied, which are:
1) Finding certain influential determinants which are in the co-integration relationship as well as the causal relationship over the time series with the new ordering for dry bulk shipping vessels.
2) To investigate how those chosen determinants will influence the new ordering for dry bulk shipping vessels, then try to find the specific correlation between the ordering for bulk vessels and other 5 variables, by the method of VECM model.
3) Finally, hoping that there can be a referential relationship between the ordering volume and other factors chosen in this dissertation for participants in the dry bulk shipping market, when investors are either going to make any investment on new fleets-buying or just managing existing shipping vessels in the company.

1.3 Planning orders of remains

The rest of parts are organized as following orders: section2 presents contributions made by the existing literature, and some imperfections are also needed to be improved in this dissertation. Section3 listed specific 5 determinants picked up to be examined by different methodologies, then section4 shows the theory model, what data were collected and all 6 methodologies which would be applied in the dissertation. Next section5 would provide practical suggestions for investors and company managers when handling decisions of investing on shipping vessels in the dry bulk shipping market. Finally, there is the conclusion and extension for the paper. Following is the flowing chart for the dissertation framework:

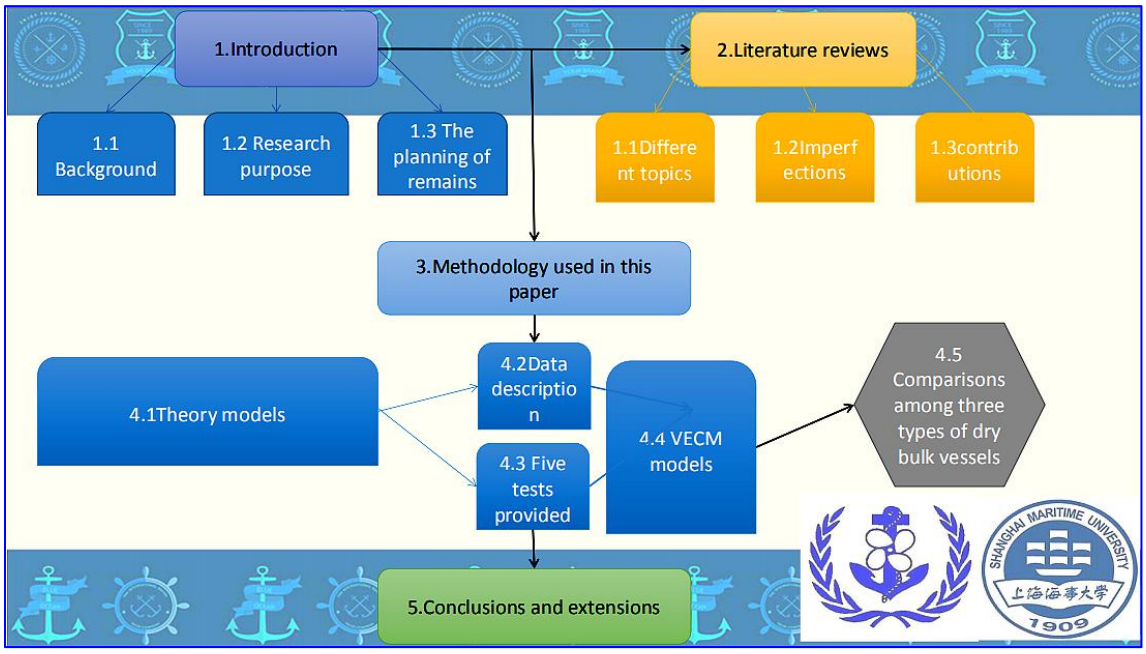


Chart1.3-1 The flowing chart of the dissertation framework.

2. Literature review

2.1 Literature reviews on dry bulk shipping market including the new-building segment and the second-handed segment

V. Puscaciu, M, Mihalache, and F.D. Puscaciu(2015) have drawn the conclusion about the tendency that despite the depression situation the shipping industry has

been in, the volume of the world fleet scored a constant growth. The paper World Fleet and the Price of the Ships explained the different well-structured segments fitting for specific commodities transported by sea in the global shipping market, and investigated the world fleet loop as well as different sectors in this fleet field, such as the new-building ships, or the scrapping part of the recycling.

Theodore Syriopoulos and Efthimios Roumpis(2007) chose two second-handed segments of dry bulk shipping market and tanker shipping market to analyse the price and volume dynamics in these two markets, by using methodologies of Granger Causality and exponential GARCH(EGARCH). According to the article, price changes could lead to the changes of capital gains, inducing the positive changes in trading volume (or activity), while the volume has the negative impact on the volatility of price changes, especially in the dry bulk shipping market. Earlier in the paper of The Price Volume Relationship in Sale and Purchase Market for Dry Bulk Vessels, Amir Alizadeh and Nikos Nomikos(2003) studied on the second-handed dry bulk shipping market where real assets are traded in this sale & purchase market. Two questions are investigated in this paper, which is the possible predictiong function of sales volume to the returns in the dry bulk market, and then a certain relationship between the volatility of ship prices and market activities traded in this segment. By using three methodologies of regressions, Granger Causality and the EGARCH model, they concluded that volume has no Granger causality with price in any market, whereas price changes do Granger cause volume activities for Panamax vessels and Handysize ships.

Then in the research written by Christiana C. Gkochari(2014), the aim is to investigate the optimal investment timing in the dry bulk shipping sector, while the methodology used is the optimal trigger strategy, which is related with linear regression. Authors introduced a pioneering method which based on option games theory, to help participants make the optimal investment decision in the competitive dry bulk shipping market under uncertainty. And in this paper, the effect of newbuildings completion

delays, or the concept of “time to build” (construction lags) is introduced, which according to the author is the main reason for the construction cascades and recession induced construction boom. Finally, the author concluded that it is hard to canceling a new-building order when the average time lags should be in terms of investment activity and the respective capacity of the yards. In the same year, another paper of Time to Build and Fluctuations in Bulk Shipping, the author Myrto Kalouptsidi(2014) specifically investigated how would the influential factor of the time to build and the factor of demand uncertainty impact on investment and prices in dry bulk second-handed market. By constructing a dynamic model of ship entry and exit, both time-varying and time to build aspects were examined in the paper, and the result shows that those factors will increase the level as well as the volatility of the investment significantly.

In the paper of the capacity retirement of the dry bulk shipping market, Amir H. Alizadeh, Siri Pettersen Strandenes, and Helen Thanopoulou(2015) investigated the probability of scrapping dry bulk ships as one of the rational choice during recession in the market according to the specific influential criteria of shipping vessels such as age, vessel types, earnings and bunker prices, and the market variables including interest rates, freight market volatility and scrap steel prices. Finally, some conclusions are that: smaller vessels get lower average earnings, and scrapping age is lower for larger vessels.

The paper of stable vessel-cargo matching in dry bulk shipping market with price game mechanism(Ziyuan Peng, Wenxuan Shan, Feng Guan and Bin Yu, 2016) has combined the model of stable vessel-cargo matching with price game mechanism in three scenarios of market dominated by shippers (usually the depressed market, and the disadvantage participants are defined as carriers) and markets dominated by carries (which usually is the prosperous market where disadvantage participants are shippers), then eventually get to the equilibrium market, and those three scenarios are all discussed in computational experiments. This paper not only listed several vital

criteria which would influence the matching choices of carriers and shippers, but also gave the series of logical steps for the matching process between the two side, by choosing formulations included revenues and costs to construct three strategies and relative proofs are given, and then two more propositions with their proofs. Finally in the computational experiments, this paper have done appropriate sensitivity analysis, followed by the results produced by the large-scale case.

Lei Dai, Hao Hu and Di Zhang(2015) studied both the new-building and second-handed shipping markets where new-building and second-handed vessels are traded as real assets to investigate the important influential factor of freight rate for shipping vessel's price, and the ship's price transmission varying from time to make reasonable decisions when investing in the global dry bulk shipping market. The BEKK GARCH model was proposed to find the volatility transmission characteristic among the freight rate market, new-building vessel market and second-handed vessel market in this global industry. As the result shows that those three markets do interact with each other by revealing the possible dynamic volatility transmission among different market using the tri-variate GARCH model, and concluded that investor should consider all the sectors when investing since a change in one particular market would finally affect all the market segments through the interaction and mutual dependence.

Roar Adland, Haiying Jia, and Siri Strandenes(2006) investigated the hypothesis of the short-term asset "bubble" in the dry bulk fright market from 2003 to 2005, which led to the diviation of asset values in the dry bulk second-handed market away from the underlying fundamentals. Methodology of VECM framework was used to find the instantaneous equilibrium relationship between new-building market, second-handed market and freight rates. The time-varying delivery lag was tested in the new-building market, while the second-handed market was co-integrated with new-building market and fundamental freight rate from empirical results.

In the paper of Investor Sentiment for Real Assets: The Case of Dry Bulk Shipping Market, Nikos C. Papapostolou, Nikos K. Nomikos, Panos K. Pouliasis, and Loannis Kyriakou(2013) took factors such like market expectations, asset valuation and liquidity in to account as shipping sentiment proxies in dry bulk shipping market, to figure out the relationship between investor sentiment and its influences for real assets. As the result, authors suggested that by offsetting the highly volatile character of the dry bulk shipping market, investors may get more advantages than just buy-and -hold the real asset.

2.2 Literature reviews on influential factors of time charter and spot freight rates in dry bulk shipping market

Manolis G. Kavussanos and Amir H. Alizadeh(2000) investigated the stochastic behaviour of seasonality in dry bulk freight rates, by a series of study across different vessel sizes, contract durations as well as the market condition of peaks and troughs, they concluded that spot rates of larger vessels with shorter contract durations are more likely to be affected by higher seasonal fluctuations. While in the earlier paper of Comparisons of volatility in the Dry-Cargo Ship Sector: Spot versus Time Charters, and Smaller versus Larger Vessels, Manolis G. Kavussanos(1996) concluded that time-charters are with higher volatility than spot rates whereas the risk of smaller vessels are less than that of larger ones under the spot rates, by extending the methodology of the ARCH class of models. These two authors have written another paper to investigate the pricing efficiency of ships in the dry bulk shipping segment, Manolis G. Kavussanos and Amir H. Alizadeh(2010) tested the market efficiency of excess returns on investments based on the VAM proposed by Campbell and Shiller, and a 3-variable VAM as well as the GARCH-M models, finally got the result that “prices for new-building and second-handed vessels are not determined efficiently in the sense of Fama.”(Efficient pricing of ships in the dry bulk sector of the shipping industry, Manolis G. Kavussanos and Amir H. Alizadeh, 2010). Lu Jing, Peter B. Marlow and Wang Hui(2008) investigated the important characteristic of freight

volatility in the paper, by using methodology of GARCH model to daily returns of freight rates indices within 6 years to show that internal shocks will continue to strengthen, while the external shocks was examined by the EGARCH model to investigate the asymmetric impact from the past innovations and the current volatility. Then the result shows that main reasons for the volatility of freight rates are the different flexibility and the variety of commodity transported on different routes. To confirm that the volatility of freight rate is time varying, Jane Jing Xu, Tsz Leung Yip, and Peter B. Marlow(2011) investigated the freight rate volatility against fleet size changes, and then concluded that vessel size changes have positive influences on freight rate volatility when the shipping vessel type of Capesize shows greater reaction among three different types.

To solve the problem that spot freight rates and the BDI, a composite index, are easily influenced by the seasonal, cyclical and highly volatile dry bulk shipping market and the non-stationary and non-linear nature of prices series, Qingcheng Zeng and Chenrui Qu(2013) used the methodology of EMD, which is based on the empirical mode decomposition, by decomposition and the problem was then re-composed into three components: 1) short-term fluctuations, or the high-frequency component (which is caused by normal market activities); 2) low-frequency component (showing the effect of extreme events), and 3) a long-term trend. Finally, some forecasting strategies for BDI are discussed in the paper in terms of results.

Hong Zhang and Qingcheng Zeng(2014) investigated the influences of seasonality (different durations) and shipping vessel types on the relationship between time charter and spot freight rates, and then analyzed the price discovery function of time charter contracts. A VECM (VAR model containing co-integration constraints) was developed to model the relationship between the TC and the spot freight rates, as well as an impulse response function is used. Later in the empirical experiment, results from VECM show that there is a two-way lead-lag relationship between the TC and spot freight rates. Finally, the paper concluded that smaller ships have larger number

of significant coefficient of lagged differences.

Roar Adland, Pierre Carious, and Francois-Charles Wolff(2015) investigated how would the observed and unobserved(under time-invariant) characteristics of charterers and owners impact on the freight rate, and considered the matching relationship on the freight rate for individual voyage charter contracts in two segments: tanker markets(VLCC as the representative) and dry bulk markets(Capesize as the representative). Authors have chosen linear function of market,vessel and route variables and so on, to make regression for both markets, explaining the pricing of freight prices. Next, they made three different specifications(conditions) presented to be assessed: 1) OLS without any fixed effects; 2) Adding charterer fixed effect and one owner fixed effect; and 3) Adding a charter-owner match fixed effect. According to the result, there is a large contribution from charterer and charter-owner match effects to freight rates in the dry bulk shipping market.

In the original paper of Judgmental Forecasting in the Dry Bulk Shipping Business: Statistical vs. Judgmental Approach, Okan DURU and Shigeru YOSHIDA(2009) compared two forecasting methodologies in the empirical study part, which are statistical extrapolation methods and judgmental methods. For statistical methods, ARIMA methodology was suggested in this paper, while expert opinion and Delphi panel methods were chosen for judgmental forecasts. In the end, results show that judgmental methods could help to fill the research gap where statistical methods could not reach., and thus judgmental methodologies have shown the significant advantages over conventional statistical methods.

2.3 Literature reviews on influential factors of interest of dry bulk shipping market

LIBOR is taken as the representative of the dry bulk shipping market interest, and the first paper of LIBOR troubles is called “Anomalous movements detection based on maximum entropy” (Aurelio F. Bariviera, María T. Martín, Angelo Plastino, Victoria

Vampa, 2015). In this paper, MaxEnt approach is used for predictions in time-series, and it mainly introduces the contamination problem of the LIBOR program, hence leading to the study on “Libor Case”, and the result shows that the prediciton power is depending on the level of deterministic device was introduced to the Libor setting. The stronger a deterministic device is, the better the prediction power is for the Liobr time series.

2.4 Weaknesses of existing literature

Those meaningful literature have made contributions not only in the theory area, but also the methodology field for participants those who are investing or going to invest in the dry bulk shipping market. For theories, firstly in the shipping markets like the new-building market and the second-handed market, several influential criteria and vital conceptions such like the construction lags, or the “time to build” were carried out. In addition, interdependence between markets has been revealed. Secondly in the influential factors part, relationships between freight rate and ship sizes, vessel prices and the vessel volume for both new-building and second-handed markets have been investigated. Meanwhile, there are literature that talk about risks and the volatility dynamics between the charter contract and the spot rate along with different types of shipping vessels. Finally, there is literature studying the interest rate, and LIBOR is the representative in the dry bulk shipping industry.

And for the methodology, the methodology of GARCH or EGARCH is usually applied to study the volatility of freight rate over time, as for the methodology of Granger Causality is used to find out the potential causal relationships between variables. Also, there are other special methodologies were applied to construct models to investigate the uncommon specific relationship among factors. For example, VECM carried out by Hong Zhang and Qingcheng Zeng(2014), GARCH-M used in the paper of Efficient pricing of ships in the dry bulk sector of the shipping industry(2010) and EMD used by Qingcheng Zeng and Chenrui Qu(2013), as well as the VAM proposed by Campbell

and Shiller to examine the market efficiency.

2.5 Contributions of the dissertation

Although it seems that either in the theory part or the methodology part, relatively comprehensive researches have been done, there are still some imperfections and hence need a compositive and integrated study to find out the relationships among several top important influential factors when they all get together in one paper. Firstly, factors mentioned in papers are comparatively separately compared or related with one or two other factors, but there hasn't been one article that investigates all the vital influential factors mentioned before, that is , there has not a summary with overall consideration. Secondly, methodologies used are usually scattered in different papers, a paper that includes overall useful methodologies for different angles such as GARCH for volatility study and Granger Causality for potential causal relationships are gathered together, to support the result more validly. Thirdly, there is no specific explanation about why these two or three factors end up with the relationship like that, maybe statistical reasons are provided from several charts and figures, but that's not enough, in my opinion, relevant judgmental explanations about social aspects(such like expectations or investor sentiments) in the market which belongs to unobserved factors compared to mathematical values in charts should be mentioned as well, to make the result and conclusion be more completed and confirmed by most of people.

And in this assignment, 6 chosen representative factors which are 1) BCI, BPI and BHI for Capesize, Panamax and Handysize shipping vessels, respectively; 2) 1year time-charter rates for three types of dry bulk ships; 3) new-building prices for Capesize, Panamax and Handysize vessels; 4) second-handed prices for Capesize, Panamax and Handysize ships and 5) LIBOR as the interest rate of dry bulk shipping market, along with 6) the ordering volume as the dependent variable. Main methodology used to investigate the specific relationships including the statistics and social expectations between variables is the VECM model, and before that,

methodologies such as the unit root test, GARCH model, co-integration test and the Granger Causality model will be applied to investigate the stationary level, market volatility, correlation and the possible causal relationship of those factors. In doing this study, more comprehensive and reliable suggestions will be carried out to help investors in the dry bulk shipping market when they are making investment decision.

3. Determinants of ordering for dry bulk shipping vessels

I would like to first of all introduce 5 factors in the dry bulk shipping market that I think might influence the ordering volume of dry bulk shipping vessels, including three shipping types which are Capesize, Panamax and Handysize. Then I want to use the VECM models to find out the specific relationship between the ordering volume and the rest of 13 independent variables representing those 5 factors in total. All the determinants that I have chosen from the internal and external mechanism of dry bulk shipping market which will influence the ordering volume are picked up for the investigation, which are:

1) The freight index(representing the spot rate) of three vessel types, which are BCI, BPI and BHI, respectively.
2) Freight rates of Capesize, Panamax and Handysize.
3) New building prices of Capesize, Panamax and Handysize.
4) Second-handed shipping prices of Capesize, Panamax and Handysize.
5) LIBOR.

3.1 Spot freight rate index for Capesize, Panamax and Handysize

Among those 5 factors, the first factor of the freight rate index of three types of ships are BCI(for Capesize), BPI (for Panamax)and BHI(for Handysize), representing the spot rate as well as the income for carriers for their transportation services. It is well known that BDI (the short version for the Baltic Dry Index) is weighted by spot freight rates on several chosen major routes, usually regarded as the barometer of the dry

bulk shipping market, and is released by the Baltic Exchange, which is a membership organization providing freight market information of both the physical and derivatives contracts for the marine industry.(https://en.wikipedia.org/wiki/Baltic_Exchange)

3.2 One year chartering rate for Capesize, Panamax and Handysize

The second one of the chartering rate stands for the time chartering income for shipowners, which has been keeping very low since the end of the 2008 for financial crisis. Chartering rate is the price for a charterer to employ a vessel from a shipowner to deliver the certain cargo. Freight rates here may be decided according to a per-ton basis over a certain route, or in terms of a total sum per day for the settled duration for a C/P.

(https://en.wikipedia.org/wiki/Chartering_(shipping))

3.3 LIBOR as the interest rate of dry bulk shipping market

The third factor of LIBOR representing the market risk, stands for the interest rate in the dry bulk shipping market. LIBOR is the London InterBank Offered Rate, released by the British Banker Association firstly in 1986, which is the average interbank interest rate that banks prepare to lend to each other. LIBOR is usually regarded as the benchmark or the basis of market interest rate for banks and other financial organizations mainly for three characteristics:

(http://www.global-rates.com/interest-rates/libor/libor.aspx)

1) It is(intended as) the measure of the borrowing cost in the interbank market.
2) It is regarded as a interest rate with free risk before the financial crisis.
3) It is assumed as the the signal of global credit market conditions.

(LIBOR troubles: Anomalous movements detection based on maximum entropy, Aurelio F. Bariviera, MarÍa T. MartÍn, Angelo Plastino and Victoria Vampa, 2015)

3.3 New-building prices for Capesize, Panamax and Handysize

As for the new-building prices and the second-handed prices, these two factors are directly related to the ordering volume of dry bulk shipping vessels. New building prices are useful indicators for reflecting the future fundamental outlook of the dry bulk shipping market, and normally, higher expectations about the future freight rates, then comes to the higher order volumes for the profitable earnings, and hence followed by the rising new-building prices, and vise versa.
(https://marketrealist.com/2013/10/higher-new-build-prices-mean-higher-dry-bulk-shipping-share-prices)
It is reported that despite the “doom and gloom” situation in the shipping market after 2008, and especially 2012, there are still shipowners who are investing in the ordering volume of new-building vessels increasingly, “triggered by low prices in various shipyards.”
(http://www.seanews.com.tr/news/101738/Dry-bulk-ship-owners-keep-building-new-vessels-on-the-back-of-lower-prices-and-improved-market-prospects.html)

3.4 Second-handed prices for Capesize, Panamax and Handysize

As we said that new-building prices are more responsible to the future outlook(or for the long run) of the dry bulk shipping vessels, the second-handed prices are sensitive to the current change in rates and are signals of the short to medium-term outlook. It is said that there is a continued fall in the second-handed dry bulk shipping market for the oversupply of “the record number of ships” which were ordered before 2008, the financial crisis, when investors still got the overly optimistic expectations about the future rates during the construction boom.
(https://finance.yahoo.com/news/fall-secondhand-vessel-prices-shows-190638456.html)

4. Data and methodology

4.1 Models

In order to establish a certain relationship basis for this study, a theory model that has been adjusted and transformed for several times is introduced, which is:

$$p_t - \pi_t = \sum_{i=0}^{n-1} \rho^i (E_t \Delta\pi_{t+1+i} - E_t r_{t+1+i}) - \rho^n (E_t p_{t+n}^{sc} - E_t \pi_{t+n}) + k(1-\rho^n)/(1-\rho) \quad (1)$$

From this equation, we can see that on the left side, p_t stands for the natural logarithm of the shipping vessel's price, while π_t stands for the natural logarithm of the operation revenue for the dry bulk shipping vessel, and E_t is the mathematical expectation. In a word, the left side represents the gap between the shipping vessel's price and the operation revenue in a natural logarithm way.

On the other hand, the first term on the right side is the present value of the gap between the operation income and the rate of return, whereas the second one is the present value of the difference between the revenue when shipping vessels sold at the second-handed price and the current operating income. Then the third one is usually considered as the risk premium, a constant term, relative to time t .

The very basic equation before a series transformation is according to the two involving parts of the income of dry bulk shipping vessels:

$$E_t R_{t+1} = \frac{E_t P_{t+1} - P_t + E_t \Pi_{t+1}}{P_t} \quad (2)$$

As we could see that R_{t+1} is the return rate of investing on shipping vessels for the period of (t+1), E_t is the mathematical expectation, to leverage the average value of random variables. On this basis, function(2) could be transformed to:

$$P_t = \frac{E_t P_{t+1} + E_t \Pi_{t+1}}{1 + E_t R_{t+1}} \quad (3)$$

Then we take natural logarithm for both sides of the two-bar equals sigh, then do the

first order expansion of Taylor's formula on the mean value $\bar{p}$ of p_t, and mean value $\bar{\Pi}$ of Π_t, according to the method raised by Campbell and Shiller(1998), then we can get the equation below:

$$\ln(1+E_tR_{t+1}) = \rho\ln(E_tP_{t+1}) + (1-\rho)\ln(E_t\Pi_{t+1}) - \ln P_t + k \quad (4)$$

In this equation, $\rho = \bar{P}/(\bar{P}+\bar{\Pi})$ and $k = -\ln(\rho) - (1-\rho)\ln(1/\rho - 1)$. Let $E_tr_{t+1} = \ln(1+E_tR_{t+1})$, $E_tp_{t+1} = \ln(E_tP_{t+1})$, and $E_t\pi_{t+1} = \ln(E_t\Pi_{t+1})$, then function (4) could be transformed into:

$$p_t = \rho E_tp_{t+1} + (1-\rho)E_t\pi_{t+1} - E_tr_{t+1} + k \quad (5)$$

Finally, we use Recursive Forward Solution to transform the function(5), and then we get the equation(6):

$$p_t = \sum_{i=0}^{n-1}\rho^i(1-\rho)E_t\pi_{t+1+i} - \sum_{i=0}^{n-1}\rho^iE_tr_{t+1+i} + \rho^nE_tp_{t+n}^{sc} + k(1-\rho^n)/(1-\rho) \quad (6)$$

In this function, p_{t+n}^{sc} is the second-handed price of time (t+n) for dry bulk shipping vessels. According to function(6), after some reorganization, the final theory model equation could be developed as that showed in the beginning, the function(1).

4.2 Data collection

All the data was collected from the Clarksons.net, the time span chosen are monthly numbers from May, 2006 to December, 2017, in which there are 2380 numbers in total.

4.2.1 BCI,BPI and BHI(spot freight index)

For the first determinant of spot freight index for three different types of dry bulk shipping vessels are that BCI(for Capesize vessels), BPI(for Panamax vessels) and BHI(for Handysize vessels). BCI used in this paper is the average BCI of C2, C3, C4,

C5 and C7, while BPI is the average of P1A_03, P2A_03, P3A_03 and P4A_03, finally BHI is the weighted Average of BHMI T / C routes.

4.2.2 1 year Time-charter rates for Capesize, Panamax and Handysize vessels

The second one is the 1 Year Time-charter Rate Capesize Bulk-carrier (Long Run Historical Series) for Capesize vessels, 1 Year Time-charter Rate of Panamax Bulk-carrier (Long Run Historical Series) for Panamax vessels, and 1 Year Time-charter Rate Handysize Bulk-carrier (Long Run Historical Series) for Handysize vessels.

4.2.3 New-building prices for Capesize, Panamax and Handysize vessels

As for new-building prices for Capesize vessels are the Capesize 176-180K DWT New-building Prices, whereas for Panamax vessels are the Panamax 75-77K DWT Bulk-carrier New-building Prices, while Handysize 38-40K DWT Bulk-carrier New-building Prices for Handysize vessels.

4.2.4 Second-handed prices for 5-year old Capesize, Panamax and Handysize vessels

When selecting the second-handed prices for Capesize, Panamax and Handysize vessels, Capesize 5 Year Old Secondhand Prices (Long Run Historical Series), Panamax 76K Bulkcarrier 5 Year Old Secondhand Prices, and Handysize 32K 5 Year Old Secondhand Prices were collected, respectively.

4.2.5 LIBOR

Finally, as for the fifth determinant of dry bulk shipping market's interest rate, LIBOR data was selected from 2006-May to 2017-Dec, which are 216 numbers in all.

To be mentioned, when examining those data by following 6 tests, all the original data was transformed in to the natural logarithm ones.

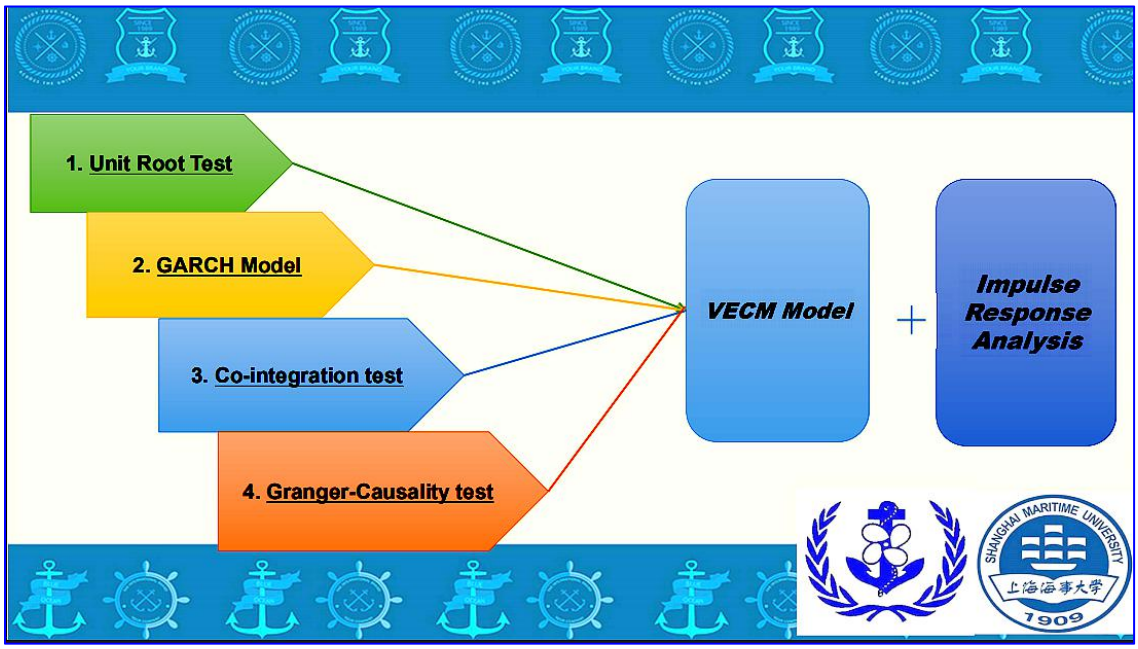


Chart2-1 The flowing chart of Methodologies used.

4.3 Unit root test: the stationary test

Table 4.3-1 Descriptive Statistics

Variables	Mean	Std. Dev.	Skewness	Kurtosis	JB Statistics
LnBDICt	1.11032	0.26640	0.50461	3.06077	5.96285
LnBDIPt	4.12522	0.36680	0.48069	2.36523	7.74192
LnBDIHt	2.85740	0.27863	0.62031	2.65824	9.65951
LnCCt	4.37960	0.36387	0.81013	2.83340	15.47597
LnCPt	4.18166	0.28909	0.69274	2.96325	11.20517
LnCHt	4.03219	0.22629	0.74598	3.07445	13.01685
LnNCt	1.75521	0.11047	0.85843	2.63375	17.97672
LnNPt	1.50479	0.10777	0.85440	2.70823	17.52984

LnNHt	1.39705	0.08657	0.89239	2.81387	18.78367
LnSECCt	1.67845	0.21773	0.87415	3.08003	17.86707
LnSECPt	1.45196	0.22564	0.65404	2.72225	10.43141
LnSECHt	1.30648	0.18352	0.33013	2.88365	2.62191
LIBOR	0.01567	0.01678	1.45548	3.63778	51.80235
LnOCt	2.57944	0.25282	-0.03452	1.83712	7.91620
LnOPt	2.67544	0.22292	-0.51640	2.32043	8.91627
LnOHt	2.76952	0.23298	-0.40423	2.47645	5.41155

It's well known that Jarque-Bera Statistics is used to test whether the sample data have the well-fitted skewness and kurtosis that could match the normal distribution. For a normal distribution, the expected skewness is zero,with value 3 for the expected kurtosis, and according to the table4.3-1, we could see that the skewness and kurtosis from the JB results for 1 year chartering rate of Handysize vessels, new-building prices and second-handed prices for all three types of dry bulk vessels are a far from the expected ones, with the increased deviation. Then we will do further study on GARCH model to get the variance sequences of the freight index for three types of dry bulk vessels.

In order to test the VECM model we need first of all provide the stationary test to all time series of the determinant variables after they're transformed into natural logarithmic as explained in the previous paragraph, and after the variables of time series are proved to be stationary, we then apply the Granger-Causality test. But before the Granger-Causality test, the co-integration test will be introduced to see if those variables connected with each other in a certain long-term stabilized way.

Table4.3-2 Unit root test for time series.

Variabkes	**Level test result**	**1st difference result**	**2nd difference result**

	ADF value	P value	ADF value	P value	Confidence level	ADF value	P value	Confidence leve
LnBDICt	-3.32	0.07	-6.05	**0.00**	1%			
LnBDIPt	-3.41	0.05	-8.13	**0.00**	1%			
LnBDIHt	-3.01	0.13	-4.04	**0.01**	5%			
LnCCt	-2.89	0.17	-3.34	0.06	10%	-8.20	**0.00**	1%
LnCPt	-3.02	0.13	-4.68	**0.00**	1%			
LnCHt	-3.12	0.11	-4.65	**0.00**	1%			
LnNCt	-2.86	0.18	-5.54	**0.00**	1%			
LnNPt	-3.11	0.11	-3.57	**0.03**	5%			
LnNHt	-2.48	0.34	-7.45	**0.00**	1%			
LnSECCt	-3.28	0.08	-6.78	**0.00**	1%			
LnSECPt	-3.52	0.04	-7.04	**0.00**	1%			
LnSECHt	-3.08	0.12	-6.05	**0.00**	1%			
LIBOR	-1.12	0.92	-7.05	**0.00**	1%			
LnOCt	-3.78	0.02	-2.63	0.26	>10%	-9.21	**0.00**	1%
LnOPt	-2.87	0.18	-2.50	0.32	>10%	-7.36	**0.00**	1%
LnOHt	3.14	0.10	-2.07	0.55	>10%	-3.27	**0.02**	5%

In order to examine the stationary of time series for variables, the software of Eviews8.0 is used to carry out the ADF unit root test, and the lag term is according to the AIC standard. Then we get tables of the level test, the 1st difference test and the 2nd difference test results above. To mention, letters from X1 to X0 in the bracket are corresponding to the related natural logarithmic data in the Excel attached, which are:

1) LnBDICt (X1): Log of BCI($/Tonne);
2) LnBDIPt (X2): Log of BPI($/Tonne);
3) LnBDIHt (X3): Log of BHI index;
4) LnCCt (X4): Log of Freight Rate of Capesize($/Long Run Historical Series);
5) LnCPt (X5): Log of Freight Rate of Panamax($/Long Run Historical Series);

6) LnCHt (X6): Log of Freight Rate of Hanysize($/Long Run Historical Series);

7) LnNCt (X7): Log of New-building prices of Capesize($/Million);

8) LnNPt (X8): Log of New-building prices of Panamax ($/Million);

9) LnNHt (X9): Log of New-building prices of Handysize ($/Million);

10) LnSECCt (X10): Log of Second-handed prices of Capesize($/Million);

11) LnSECPt (X11): Log of Second-handed prices of Panamax ($/Million);

12) LnSECHt (X12): Log of Second-handed prices of Handysize ($/Million);

13) LIBOR (X0): Log of LIBOR

In terms of the table4.3-2, it is clear that most of the time series of variables from lnBDICt to LIBOR are significant at the confidence level of 1% when under the first-order difference test, some of them are at the level of 5% or 10%.

In a word, time series from lnBDICt to LIBOR are stationary sequences under 1st difference test of the unit root test, whereas lnCCt, lnOCt, lnOPt and lnOHt are significant at the confidence level of 1%, 1%, 1% and 5%(only include intercept and without trend when testing), respectively, and hence are the stationary sequences under the second-order difference test.

4.4 GARCH model: the risk estimation

Table 4.4-1 Result of the GARCH Model of BCI, BPI and BHI

Variance	**lnBDICt**	**lnBDIPt**	**lnBDIHt**
Model	**GARCH-M(3,1)**	**GARCH(2,2)**	**GARCH(2,1)**
Mean Equation			
σ_t^2	-1.85891 (-0.3380)		
C		0.02327 (0.8165)	-0.01883 (0.7149)
Ln_{t-1}	1.01756 (0.0000)	0.99748 (0.0000)	1.00997 (0.0000)
Variance Equation			
C	0.00047	0.00400	0.000650

	(0,2366)	(0.1023)	(0.3993)
u_{t-1}^2	0.34600 (0.0115)	0.22648 (0.1023)	0.59743 (0.0000)
u_{t-2}^2	-0.36157 (0.0150)	0.41247 (0.0100)	-0.32728 (0.2677)
u_{t-3}^2	0.07903 (0.3234)		
σ_{t-1}^2	0.88154 (0.0000)	-0.06436 (0.8484)	0.62587 (0.0975)
σ_{t-2}^2		0.18069 (0.5558)	
AIC	-2.07346	-1.62020	-2.60683
SC	-1.92568	-1.47242	-2.48016
Log Likelihood	151.10520	119.60360	187.17460
D. W. test	1.56645	1.52955	1.27560
Root Mean Squared Error	0.33204	1.17399	1.85017

The GARCH model is applied to test the volatility of the market risk, and then according to the forecast results of GARCH Model on lnBDICt, lnBDIPt and lnBDIHt, on one hand we could see from table4.3-1, the root mean squared error (representing the sample standard deviation, which is scale-independent) of RISKPt and RISKHt are bigger than that of RISKCt, which means the values for predicted Panamax and Handysize vessels are less of accuracy against the values actually observed compared with that for Capesize vessels. Also, the result is the same as for the bias proportion of the forecast results for LnBDICt, LnBDIPt and LnBDIHt. As we know, the bias proportion is used to reflect the variance proportion of the difference between the forecast and the real values observed.

And on the other hand, we could get three new sequences which are the variance sequence of RISKCt, the variance sequence of RISKPt and the variance sequence of RISKHt.

4.5 co-integration test of new-building and second-handed prices

On the basis of the theory model in the first paragraph, co-integration test among the time series which have been proved to be stationary, such as the ordering quantity for new-building dry bulk shipping vessels, the new-building price, the second-handed price and the 1-year chartering rate of Capesize, Panamax and Handysize vessels have been taken to test mainly for the purpose that to see whether there is a certain long-term stabilized co-integration relationship among those chosen variables.

Table4.5-1 Co-integration test among the ordering and the 1-year chartering rate, new-building prices as well as second-handed prices.

Vessel Type	Null hypothesis	Eigenvalue	Trace Statistics	Max-Eigen Statistics
Capesize	0 co-integration vector	0.24623	90.95696 (0.0000)	39.00769 (0.0017)
	At most 1	0.17413	51.94926 (0.0004)	26.40129 (0.0126)
Pananmax	0 co-integration vector	0.55638	151.75730 (0.0000)	112.16440 (0.0000)
	At most 1	0.18459	39.59284 (0.0157)	28.16133 (0.0068)
Handysize	0 co-integration vector	0.37049	112.61920 (0.0000)	63.86808 (0.0000)
	At most 1	0.19308	48.75107 (0.0010)	29.60486 (0.0040)

From the table shown above, it is clear that when there's at most 1 integration vector, the P-value of both the trace statistics and max-eigen statistics are significant under the confidence level of 5%, according to the rejection of the hypothesis at the 0.05 level. In this way, time series of 1-year chartering rate, new-building prices and

second-handed prices are in the co-integration relationship with the ordering for particular dry bulk vessels.

After having drawn the conclusion that for Capesize vessels, Panamax vessels and Handysize vessels, the ordering quantity has a certain long term stabilized relationship with the 1 year chartering rate, new-building prices and second-handed prices, we could then follow the step and the trend to examine how they're related with each other and in what way the determinants are influencing the ordering quantity of dry bulk shipping vessels by using the VECM model, along with the impulse response analysis method.

4.6 Granger-Causality test

After having got the result that all the selected determinants are stationary and there has been a certain long-term stabilized connection among them, we will go further to check will the possible causality works out among them. Firstly, from the table4.6-1 for Capesize vessels, we know that:

Table4.6-1 Granger-Causality test results for Capesize vessels.

Capesize	Variable Function	LnOCt (Y1)	LnTCCt (X4)	LnNCt (X7)	LnSECCt (X10)
	LnOCt (Y1)		**2.E-05**	**2.E-06**	**5.E-06**
	LnTCCt (X4)	0.1608		**0.0186**	0.5027
	LnNCt (X7)	**0.0004**	**0.0006**		**0.0006**
	LnSECCt	0.4364	**8.E-10**	**0.0013**	

	(X10)				

1. The ordering for Capesize vessels (Y1) does not Granger-cause the 1-year chartering rate (X4), while the chartering rate does Granger-cause the ordering quantity.

2. The ordering (Y1) and the new-building price of Capesize vessels (X7) do Granger-cause with each other.

3. The ordering (Y1) does not Granger-cause the second-handed price (X10), whereas the second-handed price Granger-causes the ordering.

4. The 1-year chartering rate (X4) does Granger-cause the new-building price (X7), and vice versa.

5. The 1-year chartering rate (X4) does Granger-cause the second-handed price (X10), but the causal influence is not mutual.

6. The new-building price (X7) does Granger-cause the second-handed price (X10), while the second-handed price does Granger-cause the new-building price, as well.

Secondly, it is clear that from the table4.6-2 for Panamax vessels:

Table4.5-2 Granger-Causality test results for Panamax vessels.

Panamax	Variable Function	LnOPt (Y2)	LnTCPt (X5)	LnNPt (X8)	LnSECPt (X11)
	LnOPt (Y2)		**0.0001**	**0.0001**	**9.E-07**

	LnTCPt (X5)	0.2202		**0.0015**	**2.E-14**
	LnNPt (X8)	**0.0443**	0.1129		**0.0002**
	LnSECPt (X11)	0.6153	0.6067	**0.0057**	

1. The ordering (Y2) does not Granger-cause the 1-year chartering rate (X5), while the chartering rate does Granger-cause the ordering.

2. The ordering (Y2) for new-building Panamax vessels and the new-building price (X8) do Granger-cause with each other.

3. The ordering (Y2) does not Granger-cause the second-handed price (X11), whereas the second-handed price does Granger-cause the ordering.

4. The 1-year chartering rate (X5) does not Granger-cause the new-building price (X8), but the new-building price does Granger-cause the 1-year chartering.

5. The 1-year chartering rate (X5) does not Granger-cause the second-handed price (X11), but the second-handed price does Granger-cause the 1-year chartering rate.

6. The new-building price (X8) does Granger-cause the second-handed price (X11), while the second-handed price does Granger-cause the new-building price, as well.

Finally, in the table4.6-3 of Handysize vessels, we could learn that:

Table4.5-3 Granger-Causality test results for Handysize vessels.

Handysize	Variable	LnOHt (Y3)	LnTCHt (X6)	LnNHt (X9)	LnSECHt (X12)

	Function				
	LnOHt (Y3)		**0.0015**	**1.E-05**	**3.E-05**
	LnTCHt (X6)	0.0855		**7.E-05**	**1.E-10**
	LnNHt (X9)	**0.0126**	0.1233		**8.E-08**
	LnSECHt (X12)	**0.0105**	0.7162	0.3123	

1. The ordering (Y3) does not Granger-cause the 1-year chartering rate (X6), while the chartering rate does Granger-cause the ordering.

2. The ordering (Y3) and the new-building price (X9) do Granger-cause with each other.

3. The ordering (Y3) does Granger-cause the second-handed price (X12), meanwhile, the second-handed price does also Granger-cause the ordering.

4. The 1-year chartering rate (X6) does not Granger-cause the new-building price (X9), but the new-building price does Granger-cause the 1-year chartering.

5. The 1-year chartering rate (X6) does not Granger-cause the second-handed price (X12), but the second-handed price does Granger-cause the 1-year chartering rate.

6. The new-building price (X9) does not Granger-cause the second-handed price (X12), while the second-handed price does Granger-cause the new-building price.

4.7 VECM equations

Table4.7-1 The VECM result of Capeszie vessels

Capesize				
Co-integration Equation				
LnOCt	LnTCCt	LnNCt	LnSECCt	c
1.0000	-4.70505 [-2.5887]	-22.08113 [-6.8585]	16.55864 [4.6350]	28.98872
Error correction term				
	$\Delta LnOCt$	$\Delta LnTCCt$	$\Delta LnNCt$	$\Delta LnSECCt$
ECM_{t-1}	-0.00092 [-0.5311]	-0.01459 [-1.7247]	0.00399 [4.6544]	-0.00994 [-3.0503]
$\Delta LnOCt$ -1	0.51284 [7.1041]	-0.02137 [-0.0605]	0.08948 [2.5026]	-0.14639 [-1.0758]
$\Delta LnTCCt$ -1	-0.00876 [-0.3670]	0.35125 [3.0073]	0.02577 [2.1800]	0.23436 [5.2089]
$\Delta LnNCt$ -1	0.33872 [2.2635]	0.98293 [1.3423]	0.41270 [5.5681]	0.97847 [3.4689]
$\Delta LnSECCt$ -1	0.00695 [0.1366]	0.13334 [0.5355]	-0.02485 [-0.9859]	0.14310 [1.4919]
c	0.08411 [0.8848]	0.57489 [1.2358]	-0.05055 [-1.0736]	0.39909 [2.2271]
LIBORt	0.11315 [0.5613]	-1.51129 [-1.5321]	0.23628 [2.3664]	-0.99489 [-2.6183]
RISKCt	-0.06813 [-0.9292]	-0.43799 [-1.2208]	0.03685 [1.0148]	-0.30477 [-2.2053]
AIC	-19.81928 (-19.80853 when is the lag of second order)			
SC	-19.05565			

	(-18.70021 when is the lag of second order)

Note that: t-statistics in [];

Table4.7-2 The VECM result of Panamax vessels

Panamax				
Co-integration Equation				
LnOCt	LnTCPt	LnNPt	LnSECPt	c
1.0000	1.96980 [7.0453]	4.56503 [4.5131]	-5.64742 [-12.315]	-9.58494
Error correction term				
	$\Delta Ln OCt$	$\Delta Ln TCCt$	$\Delta Ln NCt$	$\Delta Ln SECCt$
ECM_{t-1}	-0.01040 [-2.6512]	-0.17780 [-10.365]	-0.01135 [-5.4232]	0.02093 [2.2075]
$\Delta Ln OCt$ -1	0.35830 [4.4709]	-0.35279 [-1.0068]	-0.01069 [-0.2502]	-0.19570 [-1.0104]
$\Delta Ln TCCt$ -1	0.00298 [0.1816]	-0.01691 [-0.2358]	0.01788 [2.04300]	-0.00043 [-0.0109]
$\Delta Ln NCt$ -1	0.00058 [0.0036]	-2.02507 [-2.8533]	0.20207 [2.3337]	0.89598 [2.2840]
$\Delta Ln SECCt$ -1	-0.07202 [-1.7185]	-0.89008 [-4.8576]	-0.02847 [-1.2736]	0.47306 [4.6709]
c	0.03966 [1.72800]	-0.05851 [-0.5831]	-0.01203 [-0.9823]	0.02344 [0.4225]
LIBORt	0.06537 [0.5416]	-0.84806 [-1.6070]	0.03244 [0.5038]	0.17919 [0.6143]
RISKCt	-0.00820 [-1.8967]	0.01320 [0.6979]	0.00212 [0.9185]	-0.00526 [-0.5029]
AIC	-18.79516 (-18.84656 when is the lag of second order)			

SC	-18.03153 (-17.73825 when is the lag of second order)

Note that: t-statistics in [];

Table4.7-3 The VECM result of Handysize vessels

Handysize				
Co-integration Equation				
LnOCt	LnTCHt	LnNHt	LnSECHt	c
1.000000	-2.31384 [-7.2097]	-3.66914 [-3.4689]	4.34748 [8.8293]	5.99856
Error correction term				
	$\Delta LnOCt$	$\Delta LnTCCt$	$\Delta LnNCt$	$\Delta LnSECCt$
ECM_{t-1}	-0.00411 [-0.8341]	0.20000 [8.7684]	0.00805 [2.6413]	-0.00996 [-0.8315]
$\Delta LnOCt$ -1	0.33761 [3.9857]	0.47945 [1.2225]	0.07291 [1.3905]	0.34405 [1.6704]
$\Delta LnTCCt$ -1	0.01079 [0.6871]	0.11963 [1.6447]	0.02966 [3.0497]	-0.00524 [-0.1371]
$\Delta LnNCt$ -1	0.13258 [1.0107]	-1.33425 [-2.1967]	0.08231 [1.0136]	0.30651 [0.9609]
$\Delta LnSECCt$ -1	0.02938 [0.6874]	-0.65088 [-3.2895]	0.10371 [3.9207]	0.27139 [2.6117]
c	0.01715 [1.5359]	-0.39523 [-7.6467]	-0.02336 [-3.3798]	0.00763 [0.2811]
LIBORt	0.18751 [1.6462]	3.36770 [6.3859]	0.21498 [3.0492]	-0.21055 [-0.7602]
RISKCt	-0.00497 [-2.1620]	0.07955 [7.4806]	0.00462 [3.2495]	-0.00105 [-0.1877]
AIC	-19.49026			

	(-19.47347 when is the lag of second order)
SC	-18.72663 (-18.36516 when is the lag of second order)

Note that: t-statistics in [];

Table4.7-4 Co-integration results of VECM for dry bulk shipping vessels

	LnTC	LnN	LnSEC
Capesize	-4.70505** [-2.5887]	-22.08113** [-6.8585]	16.55864** [4.6350]
Panamax	1.96980** [7.0453]	4.56503** [4.5131]	-5.64742** [-12.315]
Handysize	-2.31384** [-7.2097]	-3.66914** [-3.4689]	4.34748** [8.8293]

We could see the table 4.7-4 and the t-statistics boundary value comparison table figure 4.7-1 as below that when the df (degree of freedom) is 139, then according to the t-statistics value of LnTCCt, LnNCt and LnSECCt for Capesize vessels, the t-statistics value of LnTCPt, LnNPt and LnSECPt for Pananmax vessels, as well as the t-statistics value of LnTCHt, LnNHt and LnSECHt for Handysize vessels, the results are all significant under the confidence level of 1% with ** in the table4.6-4 as shown above.

After having compared with the results of AIC and SC under the lag of first order and the lag of second order, we can see from the figure 4.6-1 to table 4.6-3 that numerical values of both AIC and SC under the lag of first order are smaller than those under the lag of second order, and hence according to the theory, AIC and SC under the lag of first order are the smallest and the optimal lag result since under this particular lag of order, they both reached the smallest numerical value.

自由度		概率，P									
ν	单侧：	0.25	0.20	0.10	0.05	0.025	0.01	0.005	0.0025	0.001	0.0005
	双侧：	0.50	0.40	0.20	0.10	0.05	0.02	0.01	0.005	0.002	0.001
1		1.000	1.376	3.078	6.314	12.706	31.821	63.657	127.321	318.309	636.619
2		0.816	1.061	1.886	2.920	4.303	6.965	9.925	14.089	22.327	31.599
3		0.765	0.978	1.638	2.353	3.182	4.541	5.841	7.453	10.215	12.924
4		0.741	0.941	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5		0.727	0.920	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6		0.718	0.906	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7		0.711	0.896	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8		0.706	0.889	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9		0.703	0.883	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10		0.700	0.879	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11		0.697	0.876	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12		0.695	0.873	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13		0.694	0.870	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14		0.692	0.868	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15		0.691	0.866	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16		0.690	0.865	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17		0.689	0.863	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18		0.688	0.862	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19		0.688	0.861	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20		0.687	0.860	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21		0.686	0.859	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22		0.686	0.858	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23		0.685	0.858	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.768
24		0.685	0.857	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25		0.684	0.856	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26		0.684	0.856	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27		0.684	0.855	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28		0.683	0.855	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29		0.683	0.854	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30		0.683	0.854	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
31		0.682	0.853	1.309	1.696	2.040	2.453	2.744	3.022	3.375	3.633
32		0.682	0.853	1.309	1.694	2.037	2.449	2.738	3.015	3.365	3.622
33		0.682	0.853	1.308	1.692	2.035	2.445	2.733	3.008	3.356	3.611
34		0.682	0.852	1.307	1.691	2.032	2.441	2.728	3.002	3.348	3.601
35		0.682	0.852	1.306	1.690	2.030	2.438	2.724	3.996	3.340	3.591
36		0.681	0.852	1.306	1.688	2.028	2.434	2.719	2.990	3.333	3.582
37		0.681	0.851	1.305	1.687	2.026	2.431	2.715	2.985	3.326	3.574
38		0.681	0.851	1.304	1.686	2.024	2.429	2.712	2.980	3.319	3.566
39		0.681	0.851	1.304	1.685	2.023	2.426	2.708	2.976	3.313	3.558
40		0.681	0.851	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
50		0.679	0.849	1.299	1.676	2.009	2.403	2.678	2.937	3.261	3.496
60		0.679	0.848	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
70		0.678	0.847	1.294	1.667	1.994	2.381	2.648	2.899	3.211	3.435
80		0.678	0.846	1.292	1.664	1.990	2.374	2.639	2.887	3.195	3.416
90		0.677	0.846	1.291	1.662	1.987	2.368	2.632	2.878	3.183	3.402
100		0.677	0.845	1.290	1.660	1.984	2.364	2.626	2.871	3.174	3.390
500		0.675	0.842	1.283	1.648	1.965	2.334	2.586	2.820	3.107	3.310
1000		0.675	0.842	1.282	1.646	1.962	2.330	2.581	2.813	3.098	3.300
∞		0.6745	0.8416	1.2816	1.6449	1.9600	2.3263	2.5758	2.8070	3.0902	3.2905

Figure4.7-1 t-statistics boundary value comparison table

From the table4.7-4, we can draw the conclusion that:

1) For both Capesize and Panamax vessels, the determinants of 1 year chartering rate and new-building prices are in the opposite relationship with the ordering quantity, but in the positive relationship with second-handed prices.

It's quite normal for the opposite relationship between the ordering quantity of new-building shipping vessels and new-building prices since when the new-building prices increase, shipowners will decrease the order-book for shipping vessels to control the expensive constructing cost. But for the negative effect the 1 year chartering rate has on the ordering quantity for Capesize and Handysize vessels, this could be explained that when the chartering cost becomes higher, the charterers will pay more to charter a shipping vessel for trading cargoes, especially while the market is still in the depression period, the cost will be much bigger compared with the profit. In the end, charterers will decrease the chartering quantity because of the loss, and the shipowners will losing the profit so they don't have a very good prospect for the future, then would stop investing more money on the new-buildings.

Then as the table shows that second-handed prices are in the positive direction with the ordering for Capesize and Handysize vessels, when the price decrease, compared with high construction cost for new-building shipping vessels, shipowners would prefer to consider buying second-handed vessels for trading cargoes.

2) Whereas for Panamax, the ordering for Pananmax vessels changes in the positive way with the 1 year chartering rate and new-building prices, instead, the second-handed prices have negative effect on the ordering quantity.

For the positive influence from the 1 year chartering rate to the ordering for new-building Panamax vessels, when the chartering rate increase, the shipowner will naturally gain more profit by giving out shipping vessels to charterers. Therefore, shipowners would prefer to invest in more new-building vessels for the good expectation for the future shipping market.

As for the positive relationship between the ordering and new-building prices for Panamax vessels, In my opinion, there are two reasons why the increase of the price

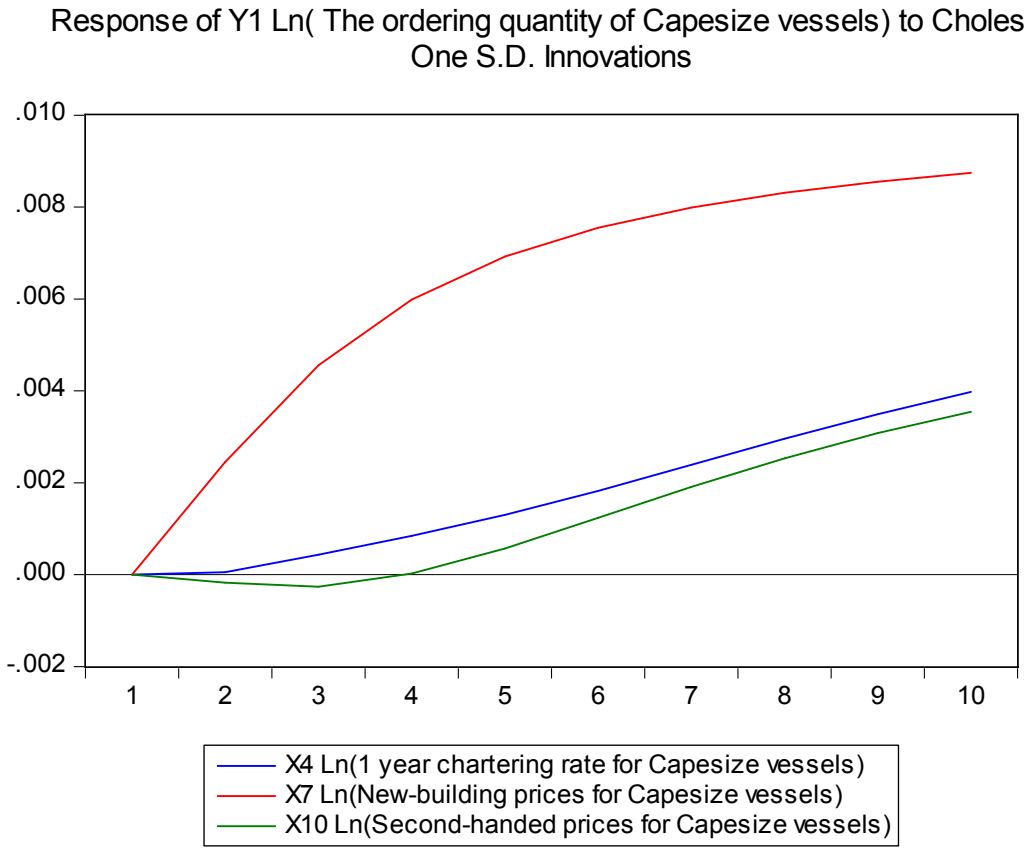
will eventually lead to the increase of the orderbook for shipping vessels. First of all, as it's well known, Panamax vessel is designed for the panama canal, which is very important and if there is the need to pass through the canal, this type of vessel can't be replaced. Then the second reason is that when the new building vessels are in great need because of increasing demand for transporting cargoes around the world, the price for constructing new-building vessels will then increase following the market theory. In this way, under the shipowners good prospect for the future, they may have the expectation that the new building price of Panamax will keep going up, so they decided to invest money right now instead of waiting for reaching the highest price, which turns out to the greater cost.

And for the negative effect of second-handed vessels on the ordering for Capesize and Handysize vessels, when the second-handed price decreases, shipowners may decide to reduce the investment of ordering new shipping vessels, and instead, they will choose to buy the second-handed ones for lower costs.

4.8 Impulse response analysis

In this part, we will use impulse response analysis to study how strong one SE unit of a determinant can influence the ordering quantity, positively or negatively.

Figure4.8-1The impulse response of Capesize vessels



As we could see from the figure 4.7-1 that the ordering quantity for Capesize vessels doesn't react immediately to all the shocks of the SE(1 year chartering rate), the SE(New-building prices) and the SE(Second-handed prices), in other words, there's a lag for the ordering quantity for Capesize vessels to make the reaction when the shock of the SE added. When faced with the first shock of the SE(1 year chartering rate), the ordering quantity increases most with a rapidly growth rate compared with the others, and then reaches to the top of 0.87% at the 10^{th} shock of the SE. Whereas the shock of the SE(New-building prices) receives the biggest response of 0.4% at the top, the shock of the SE(Second-handed prices) makes the ordering quantity increase to approximately 0.35% at most for the 10^{th} shock.

Figure4.8-2The impulse response of Panamax vessels

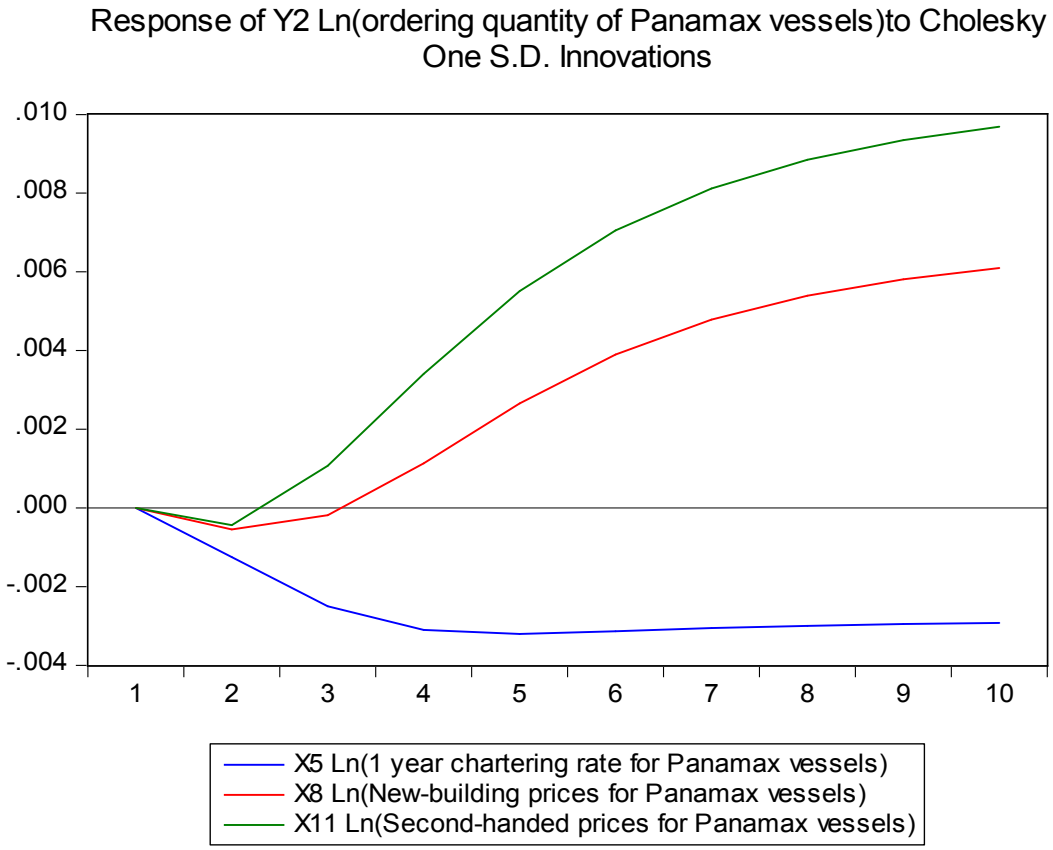
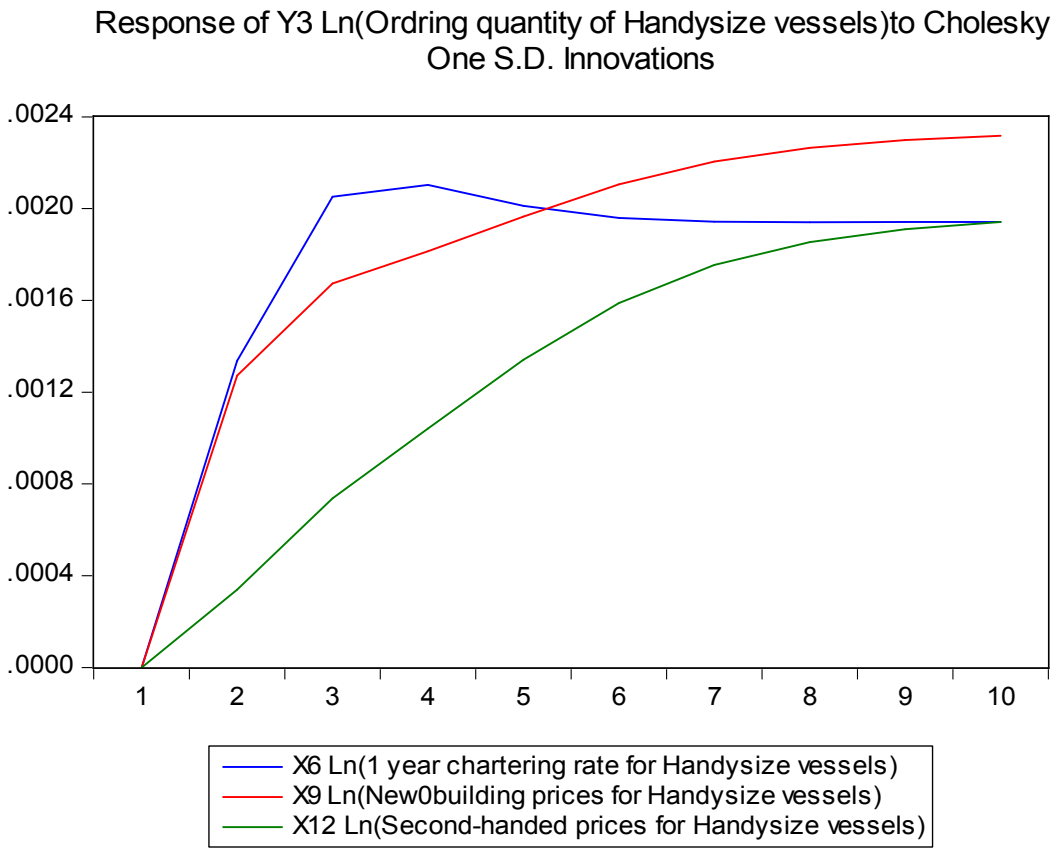


Figure4.8-3 The impulse response of Handysize vessels



According to the figure4.7-2, the ordering quantity for Panamax also reacts with a lag, and decreases for the first shock of the SE(1 year chartering rate), the SE(New-building prices) and the SE(Second-handed prices), especially for the determinant of the 1 year chartering rate. When the second shock of the SE of new-building prices and the SE of second-handed prices are added to the ordering quantity, the lines go up with increasing growth rate, while the line of the response to 1 year chartering rate keeps going oppositely for the whole period and also with a growth rate. The top point for the response line to second-handed prices is 0.97%, followed by the highest point of about 0.61% for the line of the response to new-building prices, while the lowest point for 1 year chartering rate line is -0.29%.

In terms of the figure 4.7-3, it's obvious that there's a lag when the ordering quantity reacts to the shock added. Similar to the results of the Capesize vessels, the ordering quantity for Handysize vessels finally reacts most to the shock of the SE of new-building prices, reaching to the top of 0.232%. But in the first 4 shocks of SE, the greatest response happens when the ordering is reacting to the shock of the SE(1 year chartering rate) and reaches to the top of 0.21%.

In a word, although at the first shock of the SE(1 year chartering rate), the ordering quantity for Handysize vessels reacts rapidly and the most with a growth rate compared with the others, but in the end, the line representing the response to the shock of the SE of new-building prices reaches to the top for both Capesize and Handysize vessels. And for Panamax vessels, the shock of the SE(New-building prices) has the most influence on the ordering quantity, and the influence is much bigger than other two types of shipping vessels, which is about 1% while the 0.9% (the response to the shock of the SE of new-building prices) for Capesize vessels, and top of only about 0.23% for the ordering responses to the shock of the SE of new-building prices for Handysize vessels.

4.9 Comparisons between the results of Capesize vessels, Panamax vessels and Handysize vessels

Table 4.9 Comparisons among Capesize, Panamax and Handysize vessels.

Methodologies used	Capesize vessels	Panamax vessels	Handysize vessels
Part1 Unit Root Test	The data of three types of Capeszie, Panamax and Handysize vessels are almost all stationary under 1st difference, when only LnCCt for Capesize vessels is stationary under 2nd difference.		
Part2 GARCH Model	The root squared error for RISKPt of Panamax vessels and RISKHt of Handysize vessels are larger than those for RISKCt of Capesize vessels.		
Part3 Co-integration Test	For Capesize, Panamax and Handysize vessels, time series of 1 year chartering rates, new-building prices and second-handed prices are all in a certain long-term stabilized relationship with the ordering quantity, and the result are all significant according to both Trace Statistics and Max-Eigen Statistics.		
Part4 Granger-Causality Test	1. 1 year chartering rate, new-building prices and second-handed prices are all do Granger-Cause the ordering quantity for Capesize, Panamax and Handysize vessels. 2. LnSECCt does no Granger-Causality to LnTCCt for Capesize vessels, while for Panamax and Handysize vessels, LnSECPt Granger-Causes LnTCPt, and LnSECHt Granger-Causes LnTCHt. 3. For Handysize vessels, LnNHt has no significant causal relation with LnSECHt, while as for Capesize and Panamax vessels, LnNCt and LnNPt have with LnSECt and LnSEPt. But LnOHt of Handysize vessels does Granger-Cause to the LnSECHt when there's no such relationship for Capesize and Panamax vessels.		

Part5 VECM Model results	Both the 1 year chartering rate and New-building prices have opposite relationship with the ordering quantity, while second-handed prices are positively related with the ordering for Capesize and Handysize vessels.	Exactly opposite with the results of Capeszie and Handysize vessels.	Both the 1 year chartering rate and New-building prices have opposite relationship with the ordering quantity, while second-handed prices are positively related with the ordering for Capesize and Handysize vessels.
Part6 Impulse response results	The ordering quantity responses most to the shock of the SE of new-building prices with a rapid growth rate.	The response of the ordering quantity to the shock of SE(Second-handed prices) is the highest, while the ordering quantity decrease when the shock of the SE(1 year chartering rate) added, and the effect is also at a growth rate.	The biggest react comes from the ordering responses to the shock of the SE of new-building prices with a first steady then rapid growth rate.
Conclusions	To sum up, there's a lot similarities between Capesize and Handysize vessels, especially for the VECM results part and impulse response reaults part, while for Panamax vessels, there are characteristics where Panamax vessels have in common with Capesize vessels or Handysize vessels, but not in a systematic way.		

5. Conclusions and suggestions for the shipping company's management on shipping investment

As we could see from the all pages of this paper by investigating and comparing three different types of shipping vessels, it's clear for the three key points listed as follows:

1) The ordering quantity do have a long-term stabilized relationship with determinants which are 1 year chartering rate, new-building prices and second-handed prices for Capesize, Panamax and Handysize vessels, and also, these determinants do Granger-cause the ordering quantity. In this way, we are confirmed that these three factors should be taken into consideration when making management decision to order or invest on shipping fleets.

2) In order to know exactly how these determinants influence the ordering quantity, we need to do further research on this relationship and that's why we introduced the VECM model as well as the impulse response analysis. According to the results, we get to know that Capesize and Handysize vessels are quite similar, their 1year chartering rate and new-building prices are in the opposite relationship with the ordering quantity, while second-handed prices have positive effect on it. But for Panamax, quite contrary, 1 year chartering rate and new-building prices are positively influencing the ordering, whereas the second-handed prices are in the opposite way.

At this point, managers need to compare the spot market and the history collected data and watch the trend and relationship referring to this conclusion, since different shipping vessel type needs different plans. Then they need to make the specific decision according to their expectations for present and the future market, after thinking of all the integrated information provided by the spot market, the history summary and in necessary, take FFA (Forward Freight Agreement) or other future derivatives as a general public reference to help make the right decision.

3) Finally, in the VECM model, we divided all the determinants into endogenous variables (which are 1 year chartering rate, new-building prices and second-handed prices) and exogenous variables (which are LIBOR and variance sequences of RISKCt, RISKPt and RISKHt). For better reflecting the shipping market freight risk, BCI, BPI and BHI for Capesize, Panamax and Handysize vessels are transformed into variance sequences by GARCH model, then in terms of the VECM results under this setting, we use endogenous variables to do further study by the use of impulse response analysis. In this way, we could learn the reaction or the response of the ordering quantity to the shock of different determinants when they change a SE, which means how the error and deviation of the ordering quantity will possibly change and then how this changing error will lead to the movement of the time series of the ordering quantity as well as other determinants. These conclusions drawn from the impulse response analysis should also be considered by managers for more mature decision and improvements during the processing project.

As for improvements for this paper, the periodicity of the shipping market as well as the possible influence of exchanging problems from different currency of different countries or regions have on the ordering quantity should also be involved into the investigation. Besides, there are more extensions can be made, for example, although we have concluded the relationship among the ordering quantity and other three endogenous variables, including how these determinants influence the ordering for shipping vessels, positively or negatively, we didn't examine the specific lead-lag relationship of the effect from time chartering rate for different period in further step by using co-integration test and VECM model, new-building prices and second-handed prices of other year-old shipping vessels also should be collected as study data in order to investigate the relationship in a more comprehensive way. And these could all be considered in future's further studies.

References

V. Puscaciu, M. Mihalache & F. D. Puscaciu.(2015). *World Fleet and the Price of the Ships.* Procedia - Social and Behavioral Sciences , 191 :2873-2878.

Syriopoulos, T. & Roumpis, E.(2006). *Price and volume dynamics in second-handed dry bulk and tanker shipping markets.* Maritime Policy & Management 33(5):497-518.

Alizadeh, A. & Nomikos, N., *The Price Volume Relationship in Sale and Purchase Market for Dry Bulk Vessels.* Maritime Policy and Management, 30, 321-337.

Gkochari, C. C.(2015).*Optimal investment timing in the dry bulk shipping sector.* Transportation Research Part E, 79 :102-109.

Kalouptsidi, M.(2011).*Time to Build and Fluctuations in Bulk Shipping*.

Alizadeh, A. H., Strandenes, S. P. & Thanopoulou, H.(2016). *Capacity retirement in the dry bulk market: A vessel based logit model.* Transportation Research Part E Logistics & Tra... , 92 :28-42.

Adland, R., Jia, H., Strandenes, S.(2006). *Asset Bubbles in Shipping? An Analysis of Recent History in the Dry Bulk Market.* Maritime Economics & Logistics, 8 (3) :223-233.

Papapostolou, N. C., Nomikos, N. K., Pouliasis, P. K. & Kyriakou, L.(2014).*Investor Sentiment for Real Assets: The Case of Dry Bulk Shipping Market.* Social Science Electronic Publishing , 18 (4) :1507–1539.

Kavussanos, M. G.& Alizadeh, A. H.(2001).*Seasonality pattern in dry bulk shipping spot and time charter freight rates.* Transportation Research Part E, 37 (6) :443-467.

Kavussanos, M. G.(1996).*Comparisons of volatility in the Dry-Cargo Ship Sector: Spot versus Time Charters, and Smaller versus Larger Vessels.* Journal of Transport Economics & Policy》 , 30 (1) :67-82.

Kavussanos, M. G., & Alizadeh, A. H.(2002).*Efficient pricing of ships in the dry bulk sector of the shipping industry.* Maritime Policy & Management, 229 (3) :303-330.

Lu J., Marlow, P. B., Wang H.(2008). *An analysis of freight rate volatility in dry bulk shipping markets.* Maritime Policy & Management, 35 (3) :237-251.

Xu, J. J., Yip, T. L. & Marlow, P. B.(2011).*The dynamics between freight volatility and fleet size growth in dry bulk shipping markets.* Transportation Research Part E , 47

(6) :983-991.

Peng, Z. Y., Han, W. X. & Guan F., Yu, B.(2016).*Stable vessel-cargo matching in dry bulk shipping market with price game mechanism.* Transportation Research Part E Logistics & Tra... , 95 :76-94.

Zeng, Q. C., & Qu, C. R.(2016).*An approach for Baltic Dry Index analysis based on empirical mode decomposition.* Maritime Economics & Logistics, Volume 18, Issue 2, pp 192–210.

Zhang, H., & Zeng, Q. C.(2015).*A study of the relationship between the time charter and spot freight rates.* Applied Economics, 47 (9) :955-965.

Adland, R., Carious, P. & Wolff, F. C.(2016).*The influence of charterers and owners on bulk shipping freight rates.* Transportation Research Part E Logistics & Tra... , 86 :69-82.

Bariviera, A. F., MartÍn, M. T., Plastino, A. & Vampa, V.(2016).*LIBOR troubles: Anomalous movements detection based on maximum entropy.* Physica A Statistical Mechanics & Its Applicat... , 449 :401-407.

DURU, O., & YOSHIDA, S.(2009).*Judgmental Forecasting in the Dry Bulk Shipping Business: Statistical vs. Judgmental Approach.* Asian Journal of Shipping & Logistics, 25 (2) :189-217.

Dai, L., Hu, H. & Zhang, D.(2015).*An empirical analysis of freight rate and vessel price volatility transmission in global dry bulk shipping market.* Journal of Traffic and Transportation Engineering (English Edition), Volume 2, Issue 5, Pages 353-361.

YAHOO! Finance.(2015).*Dry Bulk Orderbook Falls: Signals a Cautious Outlook*. Retrieved November 20, 2017 from the World Wide Web: https://finance.yahoo.com/news/dry-bulk-orderbook-falls-signals-210613220.html

Wekipedia.(2015).*Baltic Exchange*.
Retrieved November 20, 2017 from the World Wide Web:
https://en.wikipedia.org/wiki/Baltic_Exchange.

Market Realist.(2013).*Overall pull-back or correction in dry bulk shares*.
Retrieved November 21, 2017 from the World Wide Web:
https://marketrealist.com/2013/10/higher-new-build-prices-mean-higher-dry-bulk-shipping-share-prices.

Sea News.(2013).*Dry bulk ship owners keep building new vessels on the back of lower prices and improved market prospects*.
Retrieved November 21, 2017 from the World Wide Web:
http://www.seanews.com.tr/news/101738/Dry-bulk-ship-owners-keep-building-new-vessels-on-the-back-of-lower-prices-and-improved-market-prospects.html.

YAHOO! Finance.(2015).*Fall in Secondhand Vessel Prices Shows Excess Capacity.*
Retrieved November 22, 2017 from the World Wide Web:
https://finance.yahoo.com/news/fall-secondhand-vessel-prices-shows-190638456.html.

国际船舶网.(2017).*2017年全球干散货市场迎来复苏*.
Retrieved November 22, 2017 from the World Wide Web:
http://wap.eworldship.com/index.php/eworldship/news/article?id=135144.

Wekipedia.(2018).*Chartering (shipping)*.
Retrieved November 23, 2017 from the World Wide Web:
https://en.wikipedia.org/wiki/Chartering_(shipping).